CHAPTER 2

BATHYTHERMOGRAPH OBSERVATIONS

INTRODUCTION

In this chapter, we briefly review the basic properties that affect sound in seawater. We then discuss the various uses of bathythermograph data and the equipment used to obtain this data, particularly the AN/SSQ-61(A) bathythermograph set and the AN/BQH-7(A) oceanographic data system. Next, we discuss the evaluation of the bathythermograph trace. We explain how to use the international bathythermograph observation reporting code and also cover the disposition of observation records. We then complete the chapter by explaining how to decode messages received from drifting environmental buoys, another valuable source of oceanographic data.

SEAWATER TRAITS AND DEFINITIONS

LEARNING OBJECTIVE: Identify the three basic properties of ocean water on which sound-path predictions are based.

Undersea Warfare (USW), which involves the detection and prosecution of hostile submarines, is one of the largest and most important missions of the U.S. Navy. One of the key factors that enable U.S. Navy submarines, surface ships, and aircraft to detect hostile submarines is our ability to predict the propagation path of sound in the ocean waters. This same knowledge also helps our submarines avoid detection by hostile ships and aircraft. Sound-path predictions are based on measurements of salinity, temperature, and depth in the ocean waters.

SALINITY

Salinity changes in deep ocean areas occur so slowly that we may, in most cases, consider salinity a constant. Salinity measurements in each ocean have been determined by oceanographic research ships and are available in many data bases. Salinity measurements are not routinely needed or made by operational ships.

TEMPERATURE

Temperature is by far the most important factor in determining sound propagation paths in the upper layers of the ocean. Surface and intermediate ocean-depth temperatures change more rapidly than in deep water, with the faster changes occurring at the surface. Hourly satellite observations allow all significant changes in sea surface temperature to be routinely monitored. However, significant changes in water temperature near the surface and at intermediate depths require ships and aircraft to routinely measure these temperatures at depths of up to 6,000 feet. Deep ocean waters change temperature so slowly that routine measurements are not required. Accurate data is available from oceanographic data bases that are updated by research ships and other sources.

OCEAN DEPTH

Ocean depth is also important to USW operations since the pressure of seawater is the dominant factor affecting sound velocity in the deep layers of the ocean. Ocean depth also affects sound propagation paths, such as bottom bounce and convergence zone.

REVIEW QUESTIONS

Q1. What property affecting sound propagation in seawater is normally considered a constant?

Q2. What is the most important factor affecting sound propagation in the upper layers of the ocean?

Q3. What is the dominant factor affecting sound speed in deep ocean layers?

USE OF BATHYTHERMOGRAPH OBSERVATIONS

LEARNING OBJECTIVES: Identify the main uses of bathythermograph data. Identify when bathythermograph observations are conducted.

The measurement and recording of subsurface water temperature at various depths is called a bathythermograph observation. Bathythermograph observations are normally conducted only in ocean depths of 100 fathoms (600 feet) or greater. The abbreviation "BT" is often used for the term *bathythermograph.*

Although most bathythermograph observations are conducted by Sonar Technicians and Aviation Warfare Systems Operators, Aerographer's Mates may conduct these observations while deployed aboard ship with mobile environmental teams. A far larger number of Aerographers routinely receive and use the transmitted observation *reports* to produce a variety of acoustic analyses and forecasts for USW support and other mission briefings. The input of accurate realtime bathythermograph data is the critical factor in determining the sound velocity profile (SVP) of a particular ocean area. It is from the SVP that the presence or absence of various acoustic propagation paths can be determined and thus exploited.

In addition to direct warfare support, bathythermograph observations are also used to analyze the location and structure of ocean fronts and eddies. These observations are an important input to numerical oceanographic models that analyze and predict ocean currents, surface temperatures, and other features. Bathythermograph observations are also archived in climatological data bases used by acoustic predictions systems; they are also used by Research and Development (R&D) activities to develop new oceanographic and acoustic models.

To be consistent with other environmental observations, the World Meteorological Organization has set standard bathythetmograph observation times as the synoptic hours—0000, 0600, 1200, and 1800 UTC. Operators should attempt to make all BT observations as close to a synoptic hour as possible. USW ships normally drop shipboard expendable bathythermograph (SXBT) probes every 6 hours, but may reduce observations to once per day when operating within the same area for more than 24 hours. At least one BT observation should be taken when a ship enters an area with a differingthermal structure, such as in the vicinity of ocean fronts, eddies, major river outflow areas, and differing water masses.

REVIEW QUESTIONS

Q4. What is the primary purpose of conducting bathythermograph observations?

Q5. What are some other important uses of bathythermograph data?

Q6. When should routine BT observations be conducted?

BATHYTHERMOGRAPH EQUIPMENT

LEARNING OBJECTIVES: Discuss the background and history of bathythermograph observations. Describe the basic operation and maintenance of the AN/SSQ-61(A) bathythermograph set and the AN/BQH-7(A) oceanographic data system.

Many different types of seawater temperature-measuring equipment are in routine use throughout the Navy. Ships and submarines conduct bathythermograph observations using both installed sensors and expendable bathythermograph probes. Aircraft deploy a sonobuoy called an airborne expendable bathythermograph (AXBT). An AXBT measures ocean temperature during the probes transit to the bottom and relays the information to the aircraft via radio signals. Aircraft use different types of recorders that will plot temperature/depth profiles. There are also many types of moored and drifting meteorological/ oceanographic buoys that are equipped with a sensor cable ("tail") that can measure the ocean temperature at fixed depths. The following text discusses only shipboard bathythermograph systems.

BACKGROUND AND HISTORY

Through the late 1950's, Aerographer's Mates conducted bathythermograph observations by lowering and recovering a cable-tethered bathythermograph probe over the side of the ship. A carbon-covered glass slide carried by the probe was removed and evaluated for each observation. In the 1960's, the electronic bathythermograph recorder AN/SSQ-56 system, using expendable bathythermograph probes, was introduced. Several system modifications were made over the years, the newest of which is designated the AN/SSQ-61(A). Beginning in late 1986, new construction surface ships began to receive the "next generation" of bathythermograph equipment, the AN/BQH-7(A) oceanographic data system. The AN/BQH-7A, also called a "bathythermograph/sound velocimeter," uses the same probes used by the AN/SSQ-(series) sets, but it

also uses an expendable sound velocity measuring probe. The "SSQ" systems will remain in use through at least the late 1990's.

The following text discusses the AN/SSQ-(series) systems, followed by the AN/BQH-7A system.

AN/SSQ-(SERIES) BATHYTHERMOGRAPHS

All of the AN/SSQ-(series) bathythermograph sets are manufactured by the Sippican Corporation, and appear very similar. The most apparent difference is the style of launcher used. Changes in the recorder are mostly in the electronics.

The AN/SSQ-61A bathythermograph system is the latest modification, which consists of an RO-326B/SSQ-56 or a RO-326C/SSQ-56 bathythermograph data recorder (fig. 2-1) and a MX-8577/SSQ-61 bathythermograph launcher (fig. 2-2). The "C" model recorder has an additional output circuit that allows for a direct connection to a remote recorder or an onboard acoustic data processor.

The AN/SSQ-60 system is almost identical to the newer SSQ-61 series except it uses an earlier model recorder, the RO-326A/SSQ-56, and a slightly different launcher. Some ships still use the older AN/SSQ-56A system, which also uses the RO-326 model recorder but an earlier model launcher, the deck-mounted MX-7594A/SSQ-56.

Since all of the SSQ series systems accept the standard expendable 1,500-foot-depth OC-14/SSQ-56

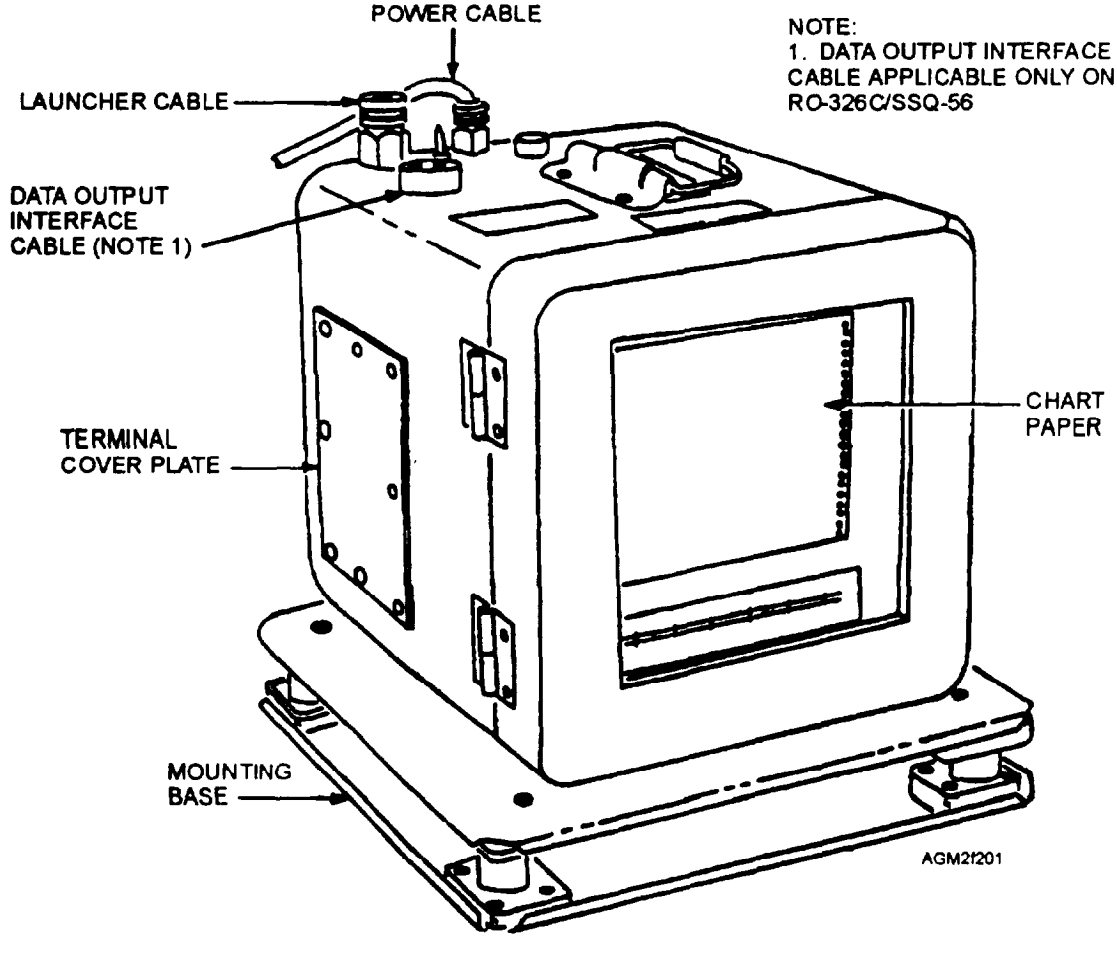


Figure 2-1.—Bathythermograph data recorder RO-326B, C/SSQ-56.

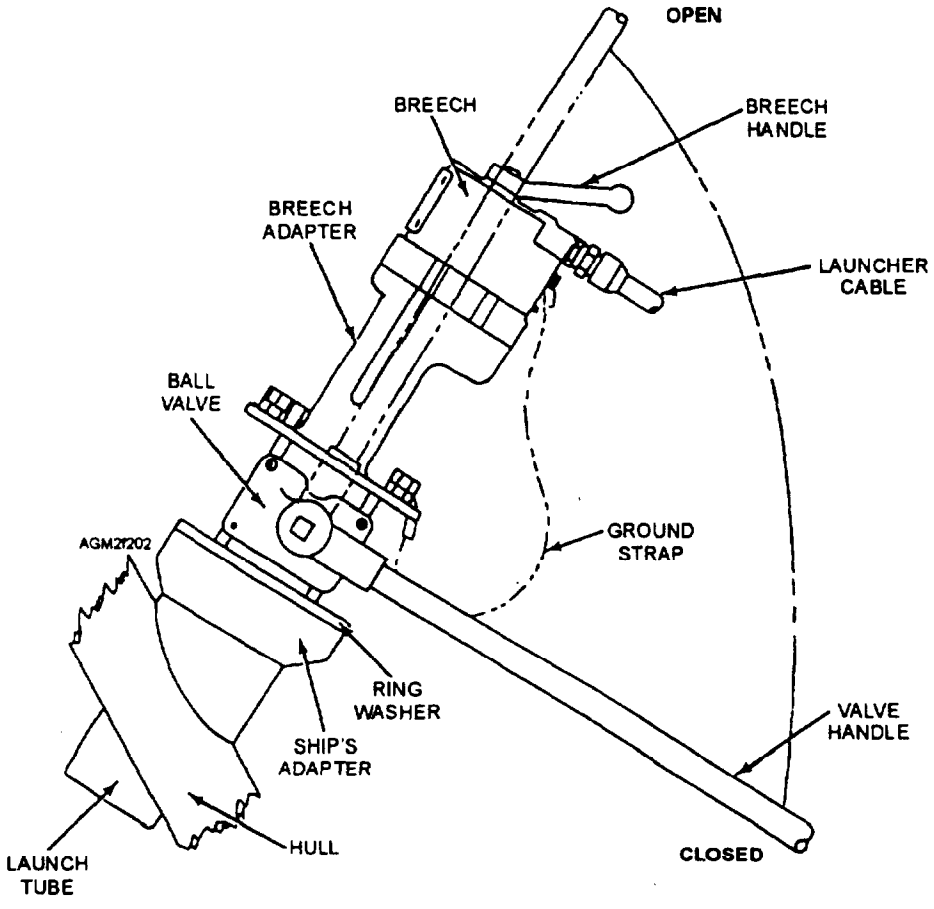


Figure 2-2.—MX-8577/SSQ-61 bathythermograph through-the-hull launcher.

bathythermograph probe (fig. 2-3), equipment components are all interchangeable. The standard probe is manufactured by the Sippican Corporation and is widely known as the T-4 probe, rather than as the OC-14/SSQ-56 probe.

An expendable bathythermograph probe is popularly called an XBT. An XBT consists of a probe with a thermistor installed in the nose and a canister. The probe descends at a known rate through the water, and the recorder converts the thermistor's electrical resistance (and descent time) into depth and temperature units. The thermistor is connected by a fine wire to contact pins mounted in the end of the canister, which is retained in the launcher during the measurement. When the measurement is completed, the wire breaks as the probe descends beyond the maximum depth of the probe. The canister is then removed from the launcher and discarded. A cable from the launcher connects to the recorder. Specific operation and maintenance instructions for each system are contained in the manualscited in the reference list.

All recorders except the original RO-326 have changeable chart drive gears and an internal selector switch that allows operation with different types of probes. All systems most commonly use the T-4 probe.

Basic Operation

An XBT observation may be conducted by one person, but it is much easier using two people with sound-powered telephones. One person should be stationed at the recorder (identified as "A") and the second person at the launcher (identified as "B"). With two people (A and B), the following sequence must be followed:

- "A": Turns on power at the recorder.
- "B": Opens launcher ball valve and breech (through-the-hull launchers).
- "B": Removes end cap from XBT, loads probe canister, and locks the breech.
- "A": Verifies automatic start sequence of recorder and chart alignment.

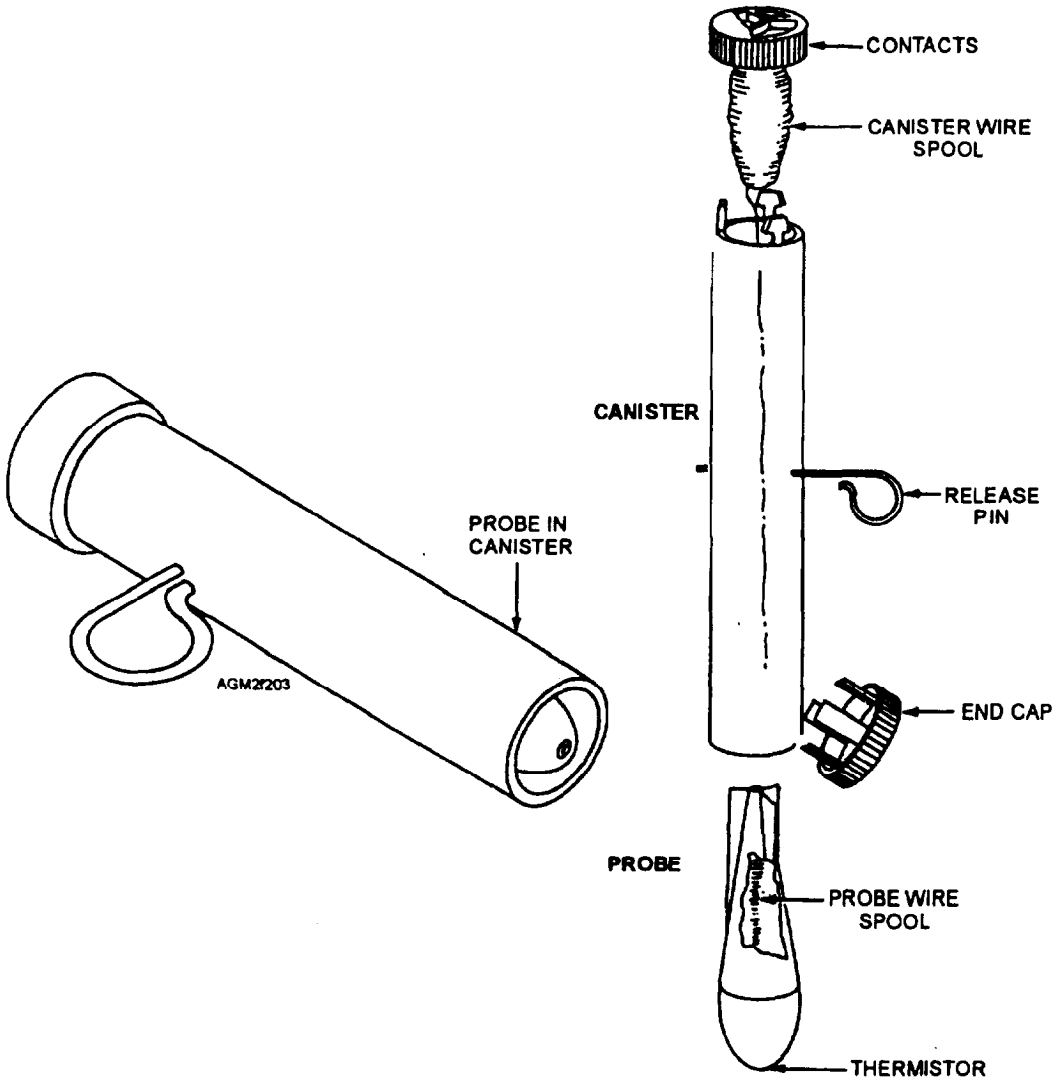


Figure 2-3.—XBT 1,500-foot-depth OC-14/SSQ-56 probe (Sippican T-4 probe).

- "B": Pulls pin out of canister to release probe.
- "A": Verifies proper recording operation.
- "B": After confirmed successful observation, removes canister and closes both ball valve and breech.
- "A": Evaluates trace (usually on the recorder), enters date/time, location, and identification data on the trace, and records/encodes data in the bathythermograph log.

Maintenance

General maintenance requirements for each AN/SSQ-(series) system are covered on maintenance requirements cards (MRCs) under the Ships' 3-M System, briefly discussed in module 1. Additional guidance may be found in the appropriate technical manuals. Some routine maintenance, such as checking and cleaning the launcher and test operating the recorder, may be done by the operator. Other maintenance requires the skills and special equipment of an Electronics Technician.

The operator normally leaves completed (and evaluated) observation recordings on the recorder after each sounding. The latest observation recording remains visible through the inspection window of the recorder case until the next observation is started. A standard chart roll records 200 observations. When the recorder chart runs out or when charts are removed, the paper must be reconnected to the take-up roller. Detailed instructions become visible on the recorder

when the recorder chart is removed. Replacement recorder charts are available in both feet/degrees Fahrenheit or meters/degrees Celsius. The metric rolls are recommended. No adjustment is needed to the recorder for either style chart. The ready-for-launch mode calibration temperature should be checked after placing a new chart on the recorder, as should the alignment of the stylus on the "surface" depth line. Figure 2-4 is an example of typical chart traces on the RO-326C/SSQ-56 data recorder.

REVIEW QUESTIONS

Q7. What is the maximum depth of the T-4 (OC-14/SSQ-56) probe?

Q8. What are the three major components of the AN/SSQ-61A system?

Q9. What does the abbreviation XBT mean?

Q10. What two items must be checked after replacing a recorder chart roll on the RO-326( )/SSQ-56 recorder?

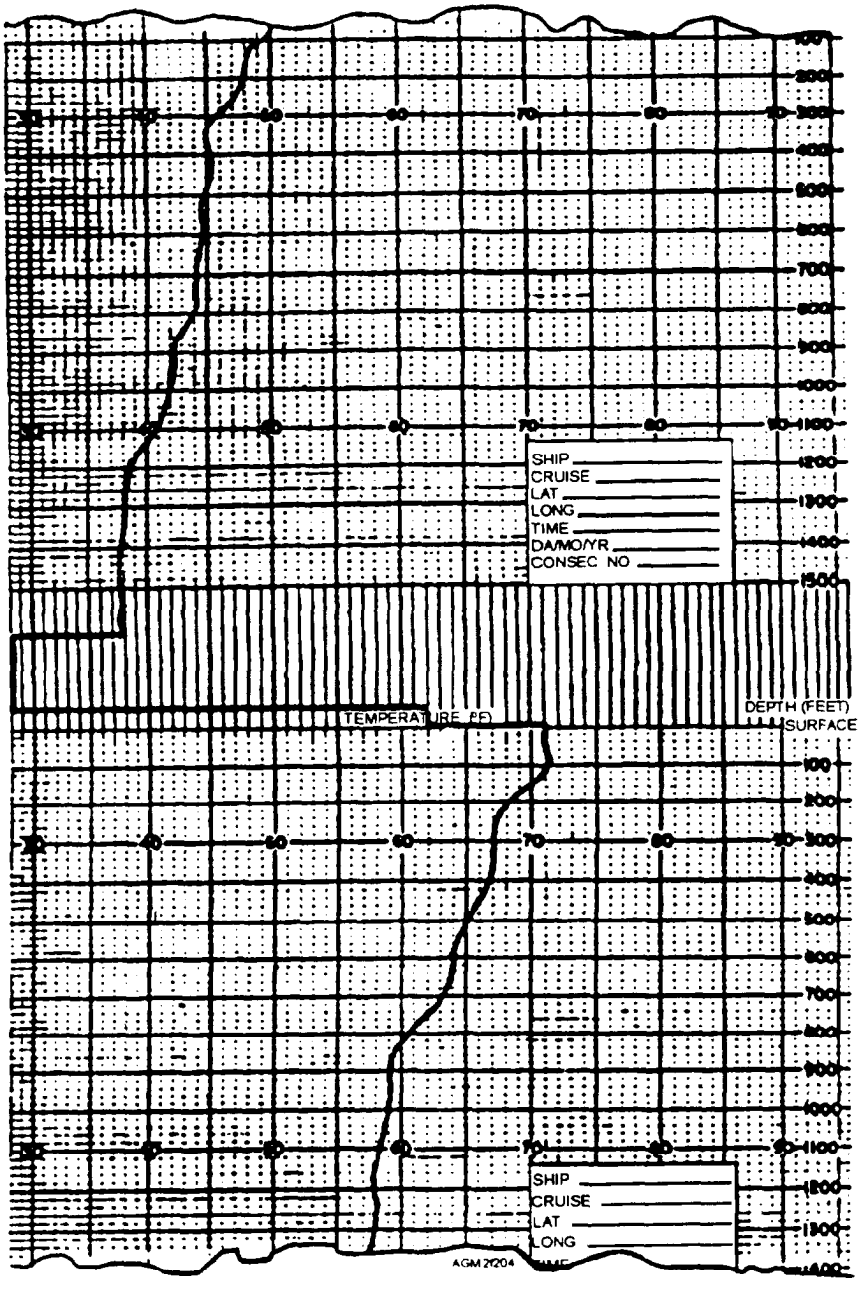
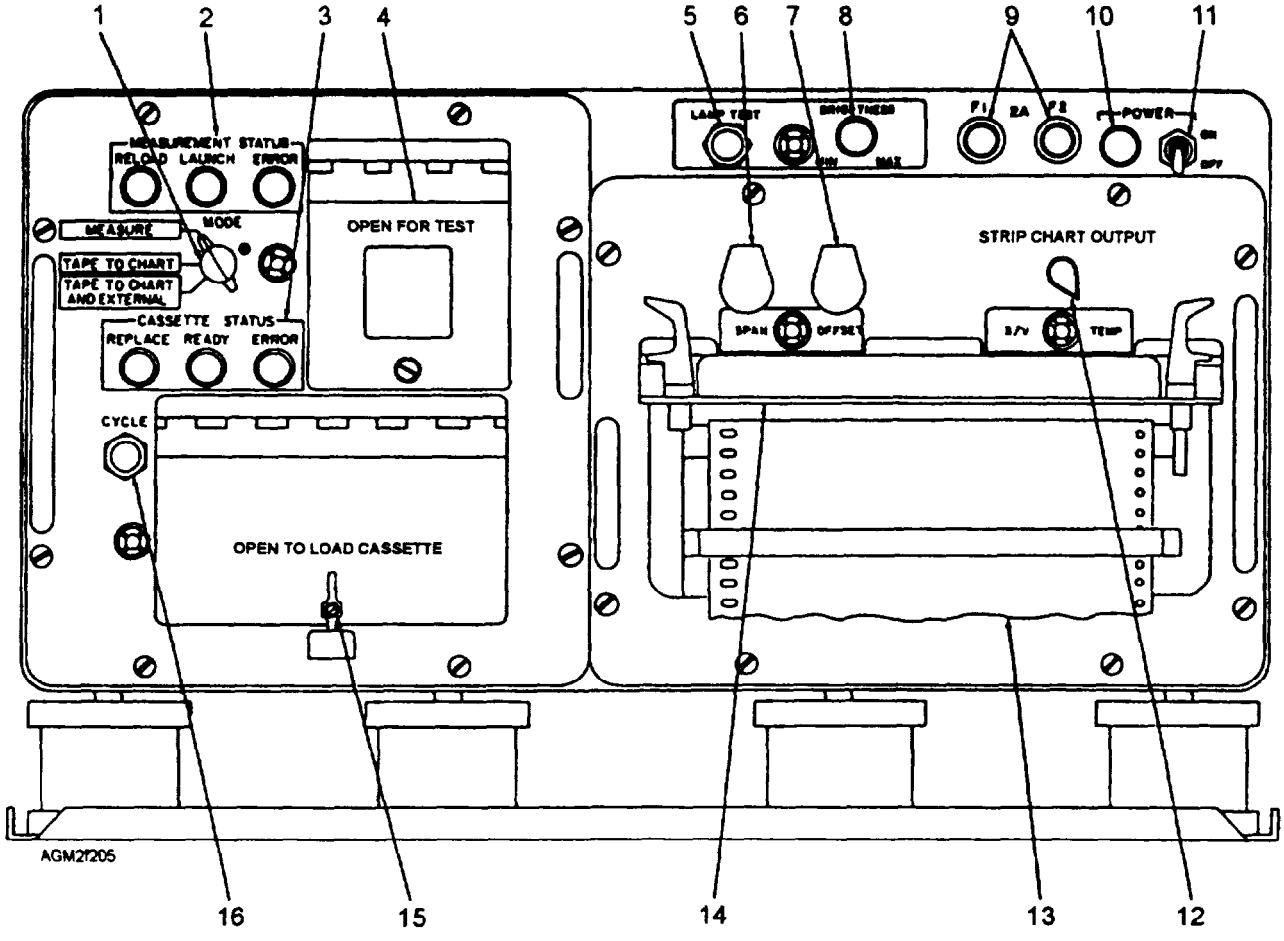


Figure 2-4.—Typical XBT chart traces on RO-326C/SSQ-56 recorder.



1. MODE switch
2. MEASUREMENT STATUS lamps
3. CASSETTE STATUS lamps
4. Test control panel door
5. LAMP TEST button
6. SPAN adjustment (for chart "width" adjustment)
7. OFFSET adjustment (aligns stylus to chart paper)
8. Lamp BRIGHTNESS Control
9. Fuses
10. Power ON indicator lamp
11. Power ON/OFF switch
12. STRIP CHART OUTPUT switch
13. Chart paper
14. OPEN TO RECORD door
15. OPEN TO RECORD CASSETTE door
16. CYCLE switch (recordings & tests)

Figure 2-5.—AN/BQH-7A oceanographic data set recorder.

AN/BQH-7(A) OCEANOGRAPHIC DATA SET

The AN/BQH-7A oceanographic data set recorder (fig. 2-5) looks very different from the AN/SSQ-(series) recorders. The recording chart paper feeds out of the chart door on the right front of the recorder; there is no take-up roll. Each chart recording must be removed from the recorder after each sounding, and the recorder door must be open during operation. As an additional feature, each sounding is also transcribed on cassette tape, which is inserted in the tape holder on the left front of the recorder.

Basic Operation

The observation procedure is very similar to that of the AN/SSQ-(series) recorders. The "reload" light illuminates after each sounding. This light goes out and the "launch" light illuminates after a new probe is inserted in the launcher. Recording (both chart and tape) automatically starts as the probe enters the water.

Like the AN/SSQ-61A system, the BQH-7A also has an auxiliary signal output cable. The AN/BQH-7A auxiliary output is a digital signal designed for direct link-up to the shipboard Navy Tactical Data System (NTDS) computer. Where shipboard tactical

environmental software is interfaced with NTDS, shipboard Aerographer's Mates have indirect access to the bathythermograph output. On temporary deployment, mobile environmental team members may need to manually enter the bathythermograph output into the Mobile Oceanography Support System (MOSS) terminal.

The AN/BQH-7A may be connected to two launchers at the same time, although only one is used for each sounding. This system uses both a hand-held LM3A launcher (fig. 2-6) and the MX-8577/SSQ-61 through-the-hull launcher. The hand-held launcher may also be used with all of the AN/SSQ-(series) systems.

The same T-4 XBT probe is used with the AN/BQH-7A system. In addition, the AN/BQH-7A also accepts the T-5 6,000-foot-deep ocean scientific probe, the T-7 2,500-foot improved sonar prediction probe, and other specialized probes. By using any of these probes, you can make the chart recording as either a depth/temperature trace or as a depth/sound velocity trace. Selection is made with the "strip chart output" selector switch, located just above the chart door. Sound velocity is internally calculated based on the measured temperature and a standard salinity of 35%. The tape may be replayed to produce either a temperature or a sound velocity trace. Normally, the temperature trace is recorded first, evaluated and encoded for transmission, and then the sound velocity trace is recorded for direct use by the shipboard Sonar Technicians.

The AN/BQH-7A also uses a different type of probe called an Expendable Sound Velocimeter (XSV) probe. The standard model is the XSV-01, that conducts sound velocity measurements to 2,790 feet (850 meters), and is shown in figure 2-7. An XSV probe uses a special sensor that produces an internal acoustic signal. The integrated circuitry of the probe then calculates the sound speed, factoring in the temperature, pressure, and salinity of the water. The sound speed values produced by an XSV are direct measurements. When this probe is used, the chart output selector is disabled and only a sound velocity profile is produced. These probes are recommended in areas where the salinity of seawater is historically different from the standard 35%, and when salinity varies with depth. When soundings are conducted by using this type of probe, a standard temperature probe must still be dropped to fulfill data collection requirements.

Detailed operating procedures are covered in the operator/technical manual *Technical Manual for Bathythermograph/Sound Velocimeter AN/BQH-7A Oceanographic Data System Surface Ship Application,* NAVSEA SE365-BA-MMO-010/BQH-7A.

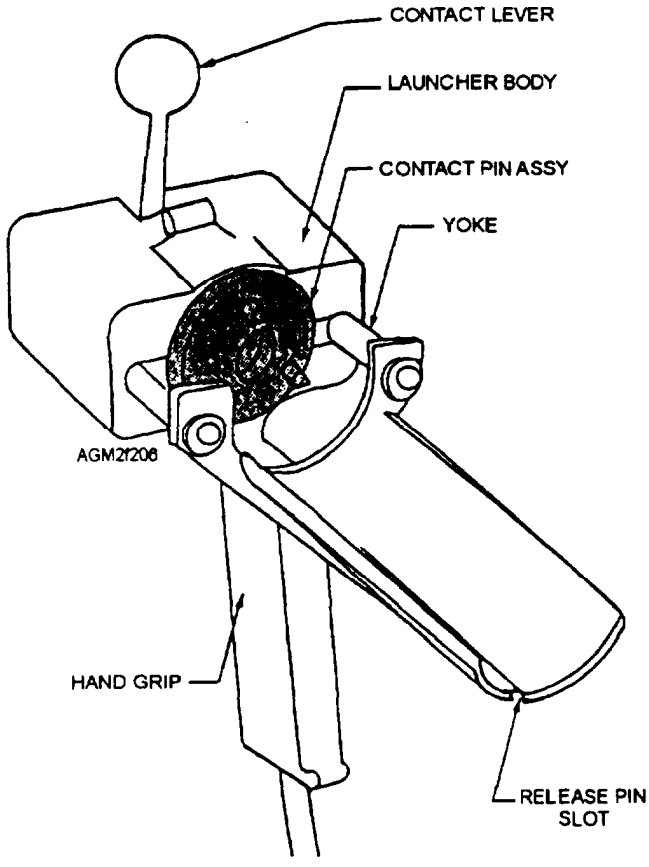
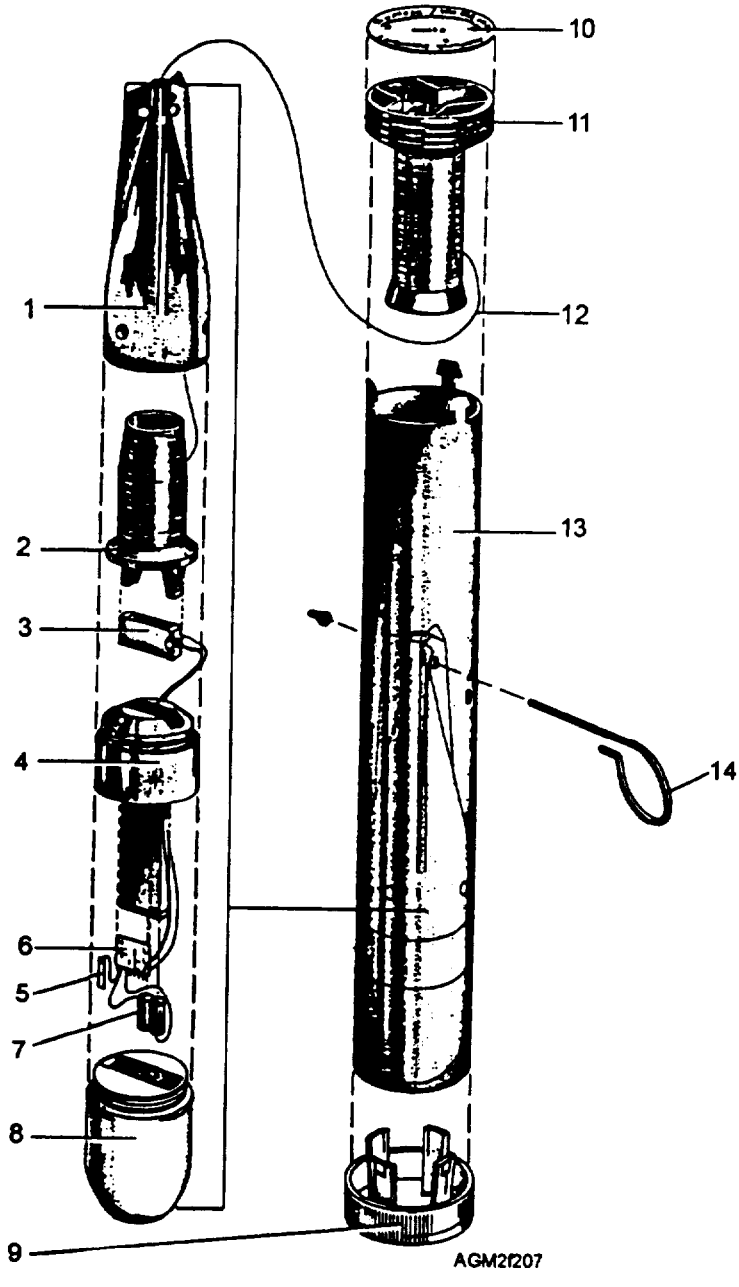


Figure 2-6.—LM3A hand-held launcher.

Maintenance

Preventive and corrective maintenance are thoroughly covered in the operator/technical manual. Preventive maintenance includes recommended **weekly** testing of the system output using a test probe, a **monthly** launcher cleaning and inspection, a **quarterly** test device performance procedure, a **semiannual** recorder and processor cleaning and inspection, and an **annual** check of the cable's signal/ground continuity and insulation resistance. At the beginning of each sounding, the operator must ensure that the ready-for-launch mode stylus alignment is made. With an XBT probe in the "temperature" mode, align the stylus at 62.0°F (±0.3°F). and with an XSV probe, align the stylus at 4,962 feet per second. Columns are predrawn on each recording chart for these readings as well as for other calibration measurements.



1. Afterbody
2. Probe spool
3. Sound velocity sensor
4. Electronics housing
5. Starting contact
6. Integrated circuit
7. Batteries
8. Zinc nose
9. Shipboard cap
10. Label
11. Shipboard spool
12. Signal wire
13. Canister
14. Retaining pin

Figure 2-7.—XSV-01 850-meter sound velocimeter probe.

Figure 2-8 shows an example of both a temperature trace and a sound velocity trace from the AN/BQH-7A recorder.

REVIEW QUESTIONS

Q11. What additional feature of the AN/BQH-7A bathythermograph system is an advantage over the AN/SSQ-61A system?

Q12. What is the main purpose of the auxiliary output cable on the AN/BQH-7A?

Q13. Besides temperature, what additional type of recording trace is produced by the AN/BQH-7A?

Q14. What is the purpose of an Expendable Sound Velocimeter?

EVALUATION OF SOUNDING TRACES

LEARNING OBJECTIVES: Recognize the anomalous recording indicators due to equipment malfunction and other unusual conditions in a bathythermograph observation. Describe how temperature and water depths are evaluated from a bathythermograph recording.

After the completion of a successful sounding, temperature and depth levels are selected for encoding and reporting. The temperature traces from all soundings must be evaluated for possible equipment malfunction prior to encoding the data. Temperature profiles from both types of recorders must also be examined for inconsistencies. Although the paper recording chart is slightly different, the indicators of

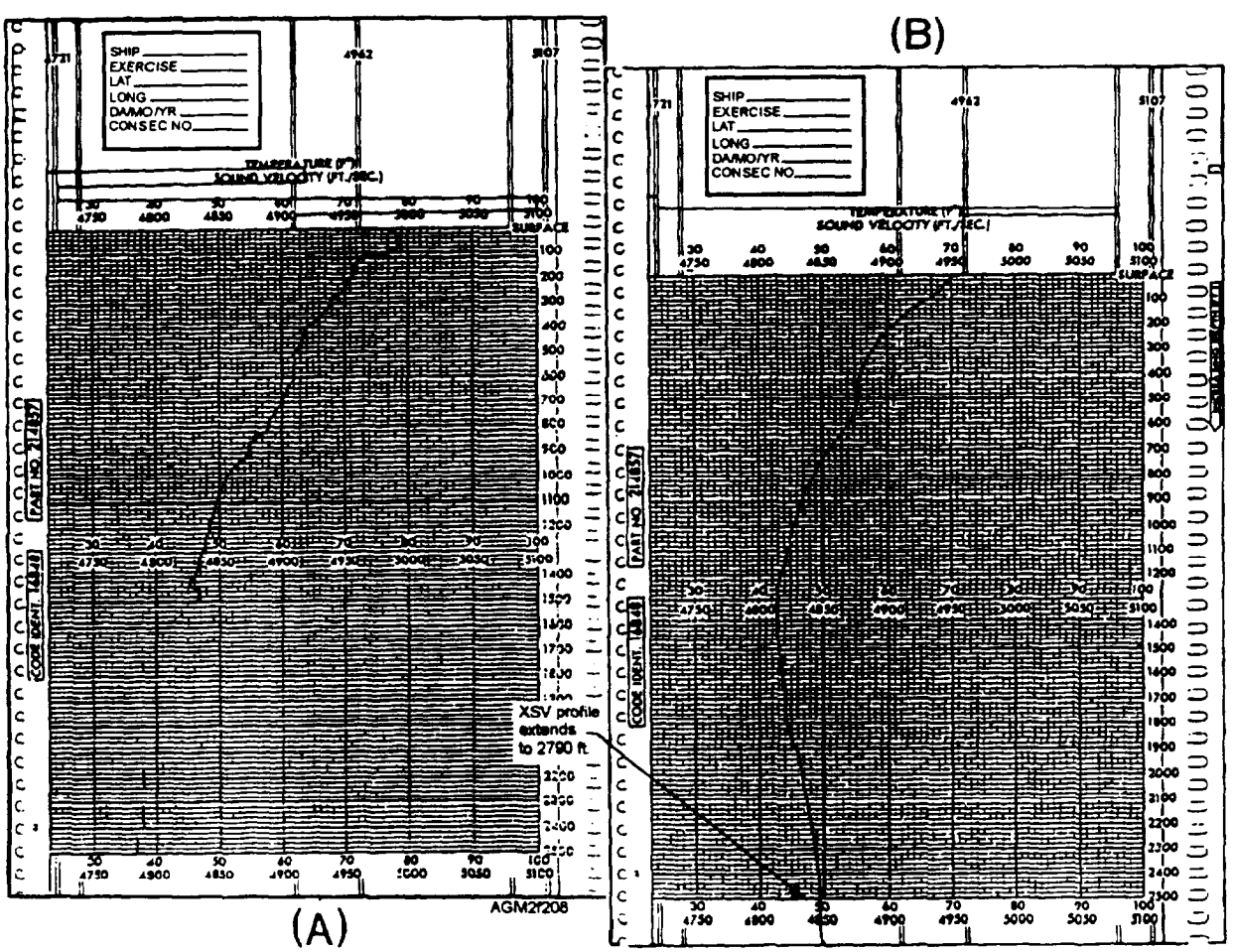


Figure 2-8.—AN/BQH-7A recorder stylus alignment in (A) temperature mode and (B) sound velocity mode.

malfunctions on both types of recorders appear basically the same. See table 2-1 for a listing of common malfunctions and corrective actions.

EVALUATION OF ANOMALOUS FEATURES

Anomalous features detected in a recorder trace from either the AN/SSQ-56 (series) recorders or the AN/BQH-7(A) recorder may invalidate the observation. Another probe should be launched after the cause of the problem is identified and corrected. Although somewhat dated, the Naval Oceanographic Office Reference Publication, RP 21, *Guide To Common Shipboard Expendable Bathythermograph (SXBT) Recording Malfunctions,* identifies and explains the cause of many trace anomalies. This publication should be thoroughly reviewed by every operator.

Obvious equipment malfunctions normally occur in less than 10 percent of all launches. However, improper handling of the probes can cause a greater number of failures than normal. Rough handling or improper storage of probes can cause the flattening or compaction of the wire in the probe and canister spools, abrasion of the insulation on the wire, or tangles in the wire. These failures can be significantly reduced by storing the probes away from extreme temperatures and humidity. Probes should always be maintained in a vertical position with the protective cap (weighted end of probe) down.

When conducting an observation, the operator should be aware of the expected thermal characteristics in the area. Large variations in thermal structure is quite common in the vicinity of ocean fronts and eddies. If anomalous features are detected in the trace that cannot be attributed to a malfunction or to an expected thermal feature, a second probe should be launched.

EVALUATION OF TEMPERATURE AND DEPTH

The evaluation of the temperature curve is a simple, straightforward matter. The observer must select significant levels on the temperature curve so that the entire curve may be reconstructed by connecting the selected points with straight lines. Temperatures are read to the nearest tenth of a degree (°C or °F) and to the nearest meter or tens of feet of depth.

Temperature Gradients

There are three terms that are used to describe the gradient (or trend) of the temperature trace on a bathythermograph chart. The first term is *positive temperature gradient,* and is defined as an increase in water temperature with depth. The next term, *negative temperature gradient,* is the opposite of positive temperature gradient, and is defined as a decrease in water temperature with depth. The last term is *isothermal gradient.* It is defined as no change in water

Table 2-1.—Common Malfunctions in Bathythermograph Recordings

SYMPTOM	CAUSE	CORRECTION
Stylus makes erratic excursions to the right of the chart paper.	Leak from probe wire to salt water.	Launch new XBT.
Stylus makes excursion all the way to left of chart paper and remains there.	Complete wire breakdown.	Launch new XBT,
Stylus makes erratic excursions to the left of chart paper.	Contamination, such as excessive salt water, between breech and canister.	Breech pins should be wiped thoroughly and new XBT inserted.
Recorder completely inactive, indicators not illuminated.	POWER switch to OFF or power cord unplugged. Fuse blown. INTERLOCK switch open.	Replace fuse.
HF radio transmission affect recorder stylus.	Electromagnetic interference.	Change capacitor.

temperature with depth. Figure 2-9 depicts the three types of temperature gradients as they would appear on a bathythermograph trace.

Selection of Significant Data Points

Certain criteria have been established for selecting data points from a bathythermograph trace. Remember that the objective of selecting these points is to provide a fairly accurate representation of the temperature profile of the water column. The following points on a bathythermograph trace are always considered significant and must be reported:

- The surface (or the first readable temperature in the upper 10 meters or 30 feet).
- The Mixed Layer Depth (MLD).
- Tops and bases of isothermal layers.
- Inflection points in the trace; that is, significant points on the trace where the temperature changes from positive to negative or vice versa.
- The deepest point of the trace. If the BT strikes the bottom, be sure to encode the value using the 00000 indicator group.

Following these procedures, there should never be a need to report more than 20 points in the upper 500 meters (1,640 feet) of the trace. Once the significant levels are selected, the sounding may be entered into onboard computer systems for processing, and then encoded in the bathythermograph log. Figure 2-10 shows an unusual bathythermograph trace from an AN/SSQ-56 recorder. Significant levels have been selected.

Some airborne expendable bathythermograph (AXBT) systems produce digital printouts of depth/temperature data vice actual depth/temperature traces. Although these can be difficult to work with, the same criteria is applied when selecting significant data points.

REVIEW QUESTIONS

Q15. What might cause the stylus on an AN/BQH-7A to make erratic excursions to the right on the recording chart?

Q16. Other than equipment or probe malfunction, what might be the cause of anomalous features on a XBT recording trace?

Q17. What term describes an increase in temperature with depth?

Q18. What significant points on a BT trace must be evaluated and encoded?

Q19. What is the maximum number of points that should be encoded in a BT observation report in the upper 500 meters (1640 feet) of the trace?

ENCODING BATHYTHERMOGRAPH SOUNDINGS

LEARNING OBJECTIVES: Describe how elements observed during a bathythermograph sounding are properly encoded in the BATHY code. Identify the meaning of each element in the BATHY code.

The CNMOC 3167/2 Bathythermograph Log contains a foldout cover sheet with complete instructions for completing the log and encoding the observation in the proper International Code, which is WMO Code FM 63-X BATHY. The Bathythermo-

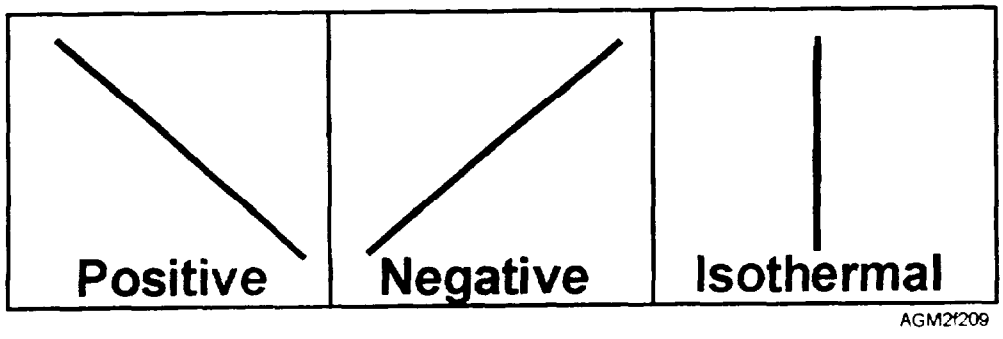


Figure 2-9.—Types of temperature gradients.

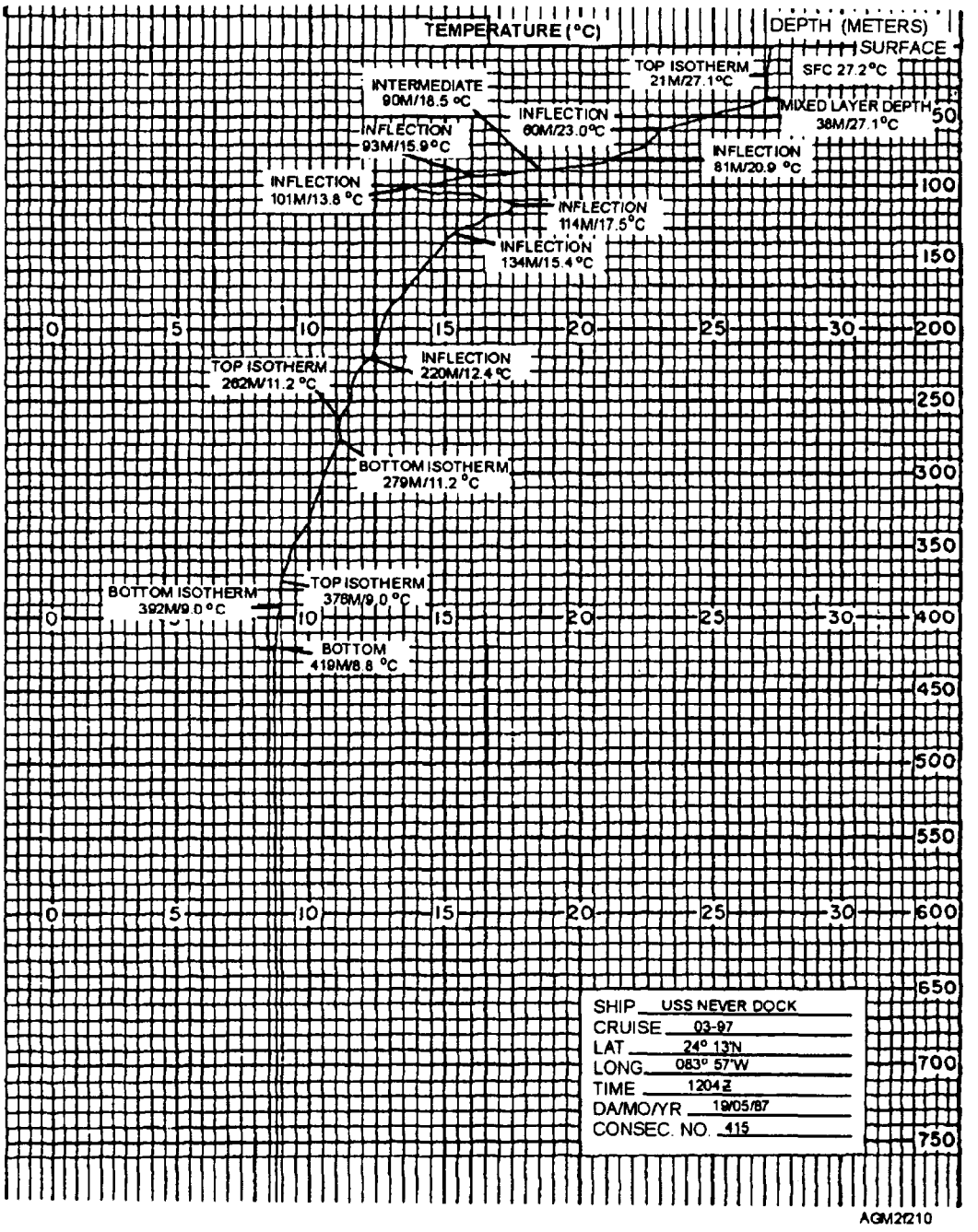


Figure 2-10.—An unusual AN/SSQ-56 recorder trace.

graph Log consists of three sections. Section I is used for reference/identification information; Section II is used for meteorological and other environmental information and also remarks; and Section III is used to encode the observation. Each page of the log contains data blocks for three observations, as shown in figure 2-11. The first section has been filled in with the data obtained from the sounding in figure 2-10. Surface

BATHYTHERMOGRAPH LOG

Prepared by the COMMANDER, NAVAL METEOROLOGY AND OCEANOGRAPHY COMMAND
in accordance with specifications established by the
WORLD METEOROLOGICAL ORGANIZATION (WMO)

FOR NAVY SHIP USE

	SHIP TYPE	HULL NUMBER	YR	MON		
B A	CG	65	7	05	P	T

FOR NAVY AIRCRAFT USE

	SOON TYPE	SOUN NMBR	SORTIE NUMBER	YR	MON		
B A						P	T

I. REFERENCE INFORMATION

PLATFORM			
TYPE	NAME USS CHOSIN	DESIGNATOR CG-65	
COUNTRY U.S.	INSTITUTION NAVY		
CRUISE NUMBER 97-02	PROJECT EXERCISE		
STATION NUMBER	OBSERVATION NUMBER 27	INSTRUMENT XBT	

II. OPTIONAL ENVIRONMENTAL INFORMATION

1 DEPTH TO BOTTOM (METERS)	2 WIND DIR	2 WIND SPEED	3 SEA LEVEL PRESSURE	4 AIR TEMP ±	4 DRY BULB	5 AIR TEMP ±	5 WET BULB
L	d d	f f	P P P P	Bx	T T T	Bx	T T T

6 SEA TEMP °C			DATA	7 WAVE PER	7 WAVE HT	8 SWELL DIR	8 SWELL PER	8 SWELL HT	9 SOLAR RADIATION	10 PRECIP	11 TRANS
T_x	T_n	T_w		P_w P_w	H_w H_w	d_w d_w	P_w	H_w H_w	LANGMIN	R	METERS

REMARKS:

I. REFERENCE INFORMATION

STATION NUMBER	OBSERVATION NUMBER	INSTRUMENT

II. OPTIONAL ENVIRONMENTAL INFORMATION

1 DEPTH TO BOTTOM (METERS)	2 WIND DIR	2 WIND SPEED	3 SEA LEVEL PRESSURE	4 AIR TEMP ±	4 DRY BULB	5 AIR TEMP ±	5 WET BULB
L	d d	f f	P P P P	Bx	T T T	Bx	T T T

6 SEA TEMP °C			DATA	7 WAVE PER	7 WAVE HT	8 SWELL DIR	8 SWELL PER	8 SWELL HT	9 SOLAR RADIATION	10 PRECIP	11 TRANS
T_x	T_n	T_w		P_w P_w	H_w H_w	d_w d_w	P_w	H_w H_w	LANGMIN	R	METERS

REMARKS:

I. REFERENCE INFORMATION

STATION NUMBER	OBSERVATION NUMBER	INSTRUMENT

II. OPTIONAL ENVIRONMENTAL INFORMATION

1 DEPTH TO BOTTOM (METERS)	2 WIND DIR	2 WIND SPEED	3 SEA LEVEL PRESSURE	4 AIR TEMP ±	4 DRY BULB	5 AIR TEMP ±	5 WET BULB
L	d d	f f	P P P P	Bx	T T T	Bx	T T T

6 SEA TEMP °C			DATA	7 WAVE PER	7 WAVE HT	8 SWELL DIR	8 SWELL PER	8 SWELL HT	9 SOLAR RADIATION	10 PRECIP	11 TRANS
T_x	T_n	T_w		P_w P_w	H_w H_w	d_w d_w	P_w	H_w H_w	LANGMIN	R	METERS

REMARKS:

III. RADIO MESSAGE INFORMATION

a. METRIC Coding Example

1 MESSAGE PREFIX	2 DATE (UTC) DAY	2 DATE (UTC) MONTH	2 DATE (UTC) YR	3 TIME (UTC) HOUR	3 TIME (UTC) MIN	QUAD	4 LATITUDE DEG	4 LATITUDE MIN	5 LONGITUDE DEG	5 LONGITUDE MIN	6 INDICATOR GROUP	7 INSTRUMENTS BT TYPE	7 INSTRUMENTS RECORDER
JJYY	19	05	57	12	04	7	24	3	08	357	0	01	02

BATHYTHERMOGRAPH TRACE READINGS

DEPTH	TEMP	DEPTH	TEMP	DEPTH	TEMP	DEPTH	TEMP	DEPTH	TEMP	DEPTH	TEMP	DEPTH	TEMP
00	272	21	271	381	271	602	306	812	094	901	855	931	599
99	901	01	388	14	759	34	549	999	027	201	249	621	112
791	112	999	903	760	900	920	900	990	904	RADIO CALL			

1 MESSAGE PREFIX	2 DATE (UTC) DAY	2 DATE (UTC) MONTH	2 DATE (UTC) YR	3 TIME (UTC) HOUR	3 TIME (UTC) MIN	QUAD	4 LATITUDE DEG	4 LATITUDE MIN	5 LONGITUDE DEG	5 LONGITUDE MIN	6 INDICATOR GROUP	7 INSTRUMENTS BT TYPE	7 INSTRUMENTS RECORDER
JJYY													

BATHYTHERMOGRAPH TRACE READINGS

DEPTH	TEMP	DEPTH	TEMP	DEPTH	TEMP	DEPTH	TEMP	DEPTH	TEMP	DEPTH	TEMP	DEPTH	TEMP
00		190	88	000	000	666	666	310	09				
										RADIO CALL NSHP			

b. ENGLISH Coding Example

1 MESSAGE PREFIX	2 DATE (UTC) DAY	2 DATE (UTC) MONTH	2 DATE (UTC) YR	3 TIME (UTC) HOUR	3 TIME (UTC) MIN	QUAD	4 LATITUDE DEG	4 LATITUDE MIN	5 LONGITUDE DEG	5 LONGITUDE MIN	6 INDICATOR GROUP	7 INSTRUMENTS BT TYPE	7 INSTRUMENTS RECORDER
JJYY													

BATHYTHERMOGRAPH TRACE READINGS

DEPTH	TEMP	DEPTH	TEMP	DEPTH	TEMP	DEPTH	TEMP	DEPTH	TEMP	DEPTH	TEMP	DEPTH	TEMP
										RADIO CALL			

AGM2N211

Figure 2-11.—Bathythermograph Observation Log.

ships, aircraft, and submarines all use the same code. Surface ships and some aircraft must take a surface weather observation at the same time the BT observation is made.

As an Aerographer's Mate, you will be required to encode or at least review bathythermograph data for dissemination. Besides its immediate operational use, BT data will also be used to develop oceanographic historical data bases. Therefore, it is imperative that a quality control check be conducted prior to transmission of the data.

Additional information on conducting and encoding bathythermograph observations is contained in OPNAVINST 3141.1, *Collection and Reporting of Bathythermograph Observations,* and in NAVMETOCCOMINST 3140.1, *United States Navy Meteorological and Oceanographic Support System Manual.*

The symbolic format of the BATHY code is shown in table 2-2.

The bathythermograph code is sent as a single message composed of four sections of data. In table 2-2, groups in parenthesis are optional. Section 1 contains identification data and may contain meteorological data; section 2 contains the instrumentation and recorder type, and the depth/temperature information; section 3 reports water depth and surface current (optional); and section 4 is the ship or ocean station identifier.

IDENTIFICATION DATA

The identification data section contains the mandatory data identifier; the year, month, and day group; the actual time of the observation; a latitude and longitude group; and the optional wind and air temperature groups.

The first group in section 1 is the data identifier, which is reported as "JJYY" for all ship, aircraft, and submarine BATHY observations.

A group not seen in many other codes is the YYMMJ. The YY is the UTC day of the month, while MM is the month in two digits, and J is the last digit of the year. For example, "JJYY 22037" indicates that a BATHY observation was taken on the 22d day of March, 1997.

Table 2-2.—Symbolic Format of WMO Code FM 63-X BATHY

SECTION	CODE FORM
1	JJYY YYMMJ GGgg/ or (GGgg9) $Q_cL_aL_aL_aL_a$ $L_oL_oL_oL_oL_o$ ($I_u$ddff) ($4s_n$TTT)
2	8888Kj $I_XI_XX_RX_R$ $Z_OZ_OT_OT_OT_O$ . . . . . $Z_nZ_nT_nT_nT_n$ 999zz $Z_nZ_nT_nT_nT_n$ (ooooo)
3	(66666 $1Z_dZ_dZ_dZ_d$ $k_5D_cD_cV_cV_c$)
4	D. . . .D or 99999 $A_1b_wn_bn_bn_b$

The time of the observation is encoded in group GGgg/ in UTC. The GG is the hour, and gg is the minutes after the hour. When the code is transmitted with depth and temperature reported in metric units (meters and degrees Celsius), the time is followed by a slant. If the operator is unable to convert observations from English units to metric units, the slant is changed to a 9. Navy bathythermograph operators will normally convert from English to metric units.

The latitude and longitude of the observation are reported in two groups, $Q_cL_aL_aL_aL_a$ and $L_OL_OL_OL_OL_o$. The Q_c is the quadrant of the globe using WMO code table 3333 (see appendix III); $L_aL_aL_aL_a$ is the latitude in degrees and minutes; and $L_oL_oL_oL_oL_o$ is the longitude in degrees and minutes. This is the only code routinely used that reports latitudes and longitudes in degrees and minutes. All of the other codes report in degrees and tenths of a degree.

The optional wind group, $i_u$ddff, is reported by most surface ships, but need not be reported by submarines and aircraft. The group starts with an indicator for wind speed, i_u, found in WMO code table 1853. This is not the same indicator used for wind speed in the land and ship Synoptic codes (WMO Code 1855). Navy ships use only code figure 3 to indicate winds measured in knots in the bathythermograph code. Wind direction is reported in hundreds and tens of degrees in dd, and speed is reported to the nearest whole knot in ff.

NOTE: Instructions accompanying the log sheet state that $\mathbf{i_u}$ should be encoded as a "0" (wind speed in meters) or a "1" (wind speed in knots). In the coded message, only a "3" (uncertified wind measuring instruments used) should be encoded as the first digit of the wind group.

Ships should also report the optional outside air temperature in group $4s_n$TTT. The 4 is the temperature indicator; s_n is the temperature sign (0 for positive or zero, and 1 for negative temperatures); and TTT is the air temperature to the nearest tenth degree, usually in degrees Celsius. This group is not reported by submarines and aircraft.

Shipboard bathythermograph operators should report both wind and air temperature, and insert these code groups between data groups 5 and 6 on the form.

DEPTH AND TEMPERATURE DATA

The largest part of the bathythermograph message, the reported significant depths and temperatures, follows the $8888k_1$ indicator group. The last digit of the group, the k_1 indicator, is the "digitization" indicator (WMO Code Table 2262). This value is normally an "8" in bathythermograph observations taken from bathythermograph recorders, and means the reported depths are at significant levels. A "7" is reported when the depths/temperatures are reported at standard levels, such as 10, 50, or 100 meters.

A recent addition to the BATHY code is the group $I_xI_xI_xX_RX_R$. The code figure $I_XI_XI_x$ is used to indicate the type of BT probe used and the fall rate equation coefficients of the probe. This group is encoded by using WMO International Code 1770, and is listed in Appendix IV. The code figure X_RX_R is used to indicate the recorder type used to conduct the observation and is based on WMO International Code 4770, also listed in Appendix IV.

NOTE: Instrument Codes 002, 032, 042, and 052 are not used with SIPPICAN MK2/SSQ-61 (Recorder Code 02) or SIPPICAN AN/BQH-7/MK8 (Recorder Code 04)

The code group $z_nz_nT_nT_nT_n$ is used to report each depth/temperature group selected as significant ($z_Oz_OT_OT_OT_O$ indicates surface data). The z_nz_n is the tens and units digit of the depth in meters, or the hundreds and tens digit of the depth in feet if in English units. The $T_nT_nT_n$ is the tens, units, and tenths value of the temperature in degrees Celsius (or degrees Fahrenheit). Water temperatures below 0.0°C are indicated by adding 5 to the tens digit. A group 999zz is inserted in the code to indicate the hundreds value (thousands for English) of the depth for the groups that follow it. In this case, the zz is the hundreds units of the depth—encoded 01 for 100 meters, 02 for 200 meters, etc., and 15 for 1,500 meters. For example, significant depths and temperatures for "surface, - 1.1°C; 10 meters, 2.0°C; 24 meters, 4.5°C; 110 meters. 4.0°C; 150 meters, 4.9°C; and 340 meters, 4.3°C" would be encoded as follows:

JJYY 14027 1254/ 14224 15239 32617 41022 88888 00102

00511 10020 24045 99901 10040 50049 99903 40043.

The same data in English units would be encoded as follows:

JJYY 14027 12549 14224 15239 32617 40280 88888 00102

00301 03356 07401 36392 49409 99901 11397.

If the last depth and temperature reported is a bottom water temperature, the last depth/temperature group will be preceded by the indicator "00000." This group is not reported if the probe stopped reporting before reaching the bottom.

BOTTOM DEPTH AND SURFACE CURRENT

Section 3 of the code follows the indicator group 66666 and reports the bottom depth and surface current. These groups are optional but should be reported by surface ships whenever the data can be measured. If both depth and current are not measured, then the entire section is not reported. If, however, either one of the elements is measured, all three groups beginning with the 66666 indicator should be included in the report, and missing data should be reported with slants. Do not report charted depths or currents. *Charted depths* and *charted currents* are those depths and currents reported on hydrographic or navigation charts.

The water depth measured by a fathometer is reported in group $1Z_dZ_dZ_dZ_d$ to the nearest whole meter (or foot if the 9 indicator is included in the time group). This group is omitted when group 00000 is included in section 2.

The measured or calculated surface current set and drift are reported in group $k_5D_cD_cV_cV_c$. The k_5 is an indicator for the method used to determine the current (WMO Code 2266). This is normally reported as a 3, meaning the current is determined from navigational location "fixes" 3 to 6 hours apart, or a 4 if the fixes are 6 to 12 hours apart. Set is the direction the surface current is moving toward, and is reported in D_cD_c in hundreds and tens of degrees True. *Drift* is the speed of the current, which is reported in V_cV_c, in units and tenths of a knot. The measured water depth and the calculated current may be obtained from the Quartermaster of the Watch (QMOW) on the bridge or the Combat Information Center (CIC).

The 66666 indicator group, bottom depth group, and the surface current group are entered on the log sheet in section III, following the depth and temperature information. See figure 2-11.

STATION IDENTIFIER

The last section of the report is the station identifier. All ships report only their International Radio Call Sign (IRCS). Aircraft report their squadron designator or the abbreviation "ACFT." Ocean station platforms and certain buoys report their assigned block and station number following a 99999 identifier group.

The example sounding shown in figure 2-10, and entered in the bathythermograph log in figure 2-11, would be received in message format as follows:

JJYY 19057 1204 /72413 08357 30907 40275 88888 00102

00272 21271 38271 60230 81209 90185 93159 99301 01138

14175 34154 99902 20124 62112 79112 99903 76090 92090

99904 19088 00000 66666 31009 NSHP

REVIEW QUESTIONS

Q20. What information is encoded in section I of the bathythermograph log (CNMOC 3167/2)?

Q21. When the last digit in the GGgg( ) group is a 9, what is being indicated?

Q22. What is the code group $4s_nTTT$ used to report?

Q23. How should the group $I_XI_XI_XX_RX_R$ be encoded when a Sippican AN/BQH-7/MK-8 recorder is being used along with a Sippican T-5 XBT probe?

Q24. How should a depth/temperature pair of 420 meters/03.4°C be encoded?

Q25. How should a depth/temperature pair of 1,312 feet/42.6°F be encoded?

Q26. What does the group 00000 99903 64102 indicate?

Q27. To what does the "set" of an ocean current refer?

BATHYTHERMOGRAPH RECORDS AND REPORTS

LEARNING OBJECTIVE: Identify what records are required to be forwarded to record collection centers.

All successful bathythermograph observations should be encoded and transmitted, regardless of classification. Bathythermograph observations are transmitted to one of two *Collective Address Designators (CADs)—OCEANO WEST* or *OCEANO EAST,* as specified in NAVMETOCCOMINST *3140.1, United States Navy Meteorological and Oceanographic Support System Manual.* All transmitted observations to either of the CADs are automatically entered in both the current information and the historical information data bases. The information then becomes available for acoustic data predictions for all fleet units through the Fleet Numerical Meteorology and Oceanography Center's data networks.

The only records required to be saved indefinitely are the originals of the completed CNMOC 3167/2 bathythermograph log sheets. Each observation must be properly identified by completing the data block preprinted on each section of the chart. As directed by NAVMETOCCOMINST 3140.1, unclassified original bathythermograph log sheets are forwarded to the National Oceanographic Data Center, NOAA/NESDIS E/OC12, 13 15 E West Highway, Silver Spring, Maryland, 20910-3282, by the fifth day of the following month. Original classified log sheets are forwarded to the Naval Oceanographic Office, 1002 Balch Boulevard, (ATTN Code N34D), Stennis Space Center, Mississippi 39522-5001, by the fifth day of the following month. A meteorological records transmittal form should accompany the log sheets in lieu of a cover letter. **NEVER** delete geographical positions to make any observation unclassified, as observations without position data are useless. Instructions for the proper packaging and handling of classified log sheets are discussed in OPNAVINST 5510.1, *Department of the Navy Information and Personnel Security Program Regulation.*

SECNAVINST 5212.5, *Navy and Marine Corps Records Disposition Manual,* provides guidance for the retention of temporary records. Temporary bathythermograph records, such as the used recorder charts removed from the "take-up" roll and any duplicate copies of the log sheets, are retained on board until no longer needed (usually no more than 6 months).

REVIEW QUESTIONS

Q28. What manual outlines procedures for the transmission of bathythermograph observation data?

Q29. Where are classified original bathythermograph log sheets mailed?

Q30. How long are duplicate copies of bathythermograph log sheets normally retained on board?

DECODING DRIFTING BUOY REPORTS

LEARNING OBJECTIVE: Identify the meaning of each element in the drifting buoy reporting code.

Many drifting buoys are deployed from ships and aircraft into the Gulf of Mexico and into the Atlantic and Pacific Oceans. Drifting buoys move with the prevailing currents and automatically report observed meteorological and oceanographic elements via satellite. There are several types of drifting buoys, and not all buoys transmit the same package of environmental data. Normally, drifting buoys sample data continuously, but data is reported only when polar-orbiting meteorological satellites pass over the buoy positions. This occurs a minimum of twice a day.

Information observed by drifting buoys is encoded in WMO International Code FM 18-XI BUOY. This code contains some elements similar to the ship Synoptic code and others similar to the Bathythermograph code. The symbolic format of the BUOY code is shown in table 2-3. The report contains 5 sections of data, identified as section 0 through section 4. Section 0 is identification information, and section 1 contains meteorological and other non-marine data. Section 2 contains surface marine data. Section 3 is used to report bathymetric readings, while the last section, section 4, is used to report engineering and quality control data.

Data from drifting buoys is relayed from satellites to designated sites around the world, where the information is checked for validity and then transmitted over environmental networks. In most cases, the data is already received from the buoy in the ZZYY format, and only the data quality indicators must be encoded.

A typical drifting buoy report, which reports weather and ocean temperatures every 10 meters to 150 meters, would appear similar to the following:

SSVX06 KARS 231145

ZZYY 93503 23027 11454 712238 095139 11119

00308 10255 29075 30132 40133 52003 22219

00262 10302 33311 88870 20010 31820 20020

31252 20030 31103 20040 31055 20050 31037

20060 31027 20070 31002 20080 31002 20090

30944 20100 30915 20110 30891 20120 30830

20130 30876 20140 30844 20150 30819 66091

20150 18135 444 201// 23027 1000/ 71227

81101 90150;

Other than the information in the buoy identification section, all other data is optional; it is reported only when available. Many drifting buoys report surface conditions until the battery fails (about 6 to 12 months), but only report subsurface temperatures/currents/depths for the first 3 to 6 months after deployment, the engineering life of the "tails."

Table 2-3.—Symbolic Format of WMO Code FM 18-XI BUOY

SECTION 0	ZZYY $A_1b_wn_bn_bn_b$ YYMMJ GGggi_w $Q_cL_aL_aL_aL_aL_a$ $L_oL_oL_oL_oL_oL_o$ ($6Q_iQ_tQ_A$/)
SECTION 1	$111Q_dQ_x$ 0ddff $1s_nTTT$ $2S_nT_dT_dT_d$ or (29UUU) $3P_OP_OP_OP_O$ 4PPPP 5appp
SECTION 2	$222Q_dQ_x$ $0s_nT_wT_wT_w$ $1P_{wa}P_{wa}H_{wa}H_{wa}$ $20P_{wa}P_{wa}P_{wa}$ $21H_{wa}H_{wa}H_{wa}$
SECTION 3	$333Q_{d1}Q_{d2}$ 8887k_2 $2z_nz_nz_nz_n$ $3T_nT_nT_nT_n$ $4S_nS_nS_nS_n$ ($66k_69k_3$ $2z_nz_nz_nz_n$ $d_nd_nc_nc_nc_n$)
SECTION 4	444 $1Q_PQ_2Q_{TW}Q_4$ $2Q_NQ_LQ_A$/ $Q_cL_aL_aL_aL_aL_a$ $L_oL_oL_oL_oL_oL_o$ or (YYMMJ GGgg/ $7V_BV_Bd_Bd_B$) $8V_iV_iV_iV_i$ $9i_dZ_dZ_dZ_d$

IDENTIFICATION SECTION

All code groups in section 0 must be included in each report with the exception of the last group. All buoy reports, even those grouped within a collective bulletin, begin with the data type identifier **"ZZYY."**

Group $A_1b_wn_bn_bn_b$ is the WMO assigned area, block, and identification number of each individual buoy. The number is assigned before the buoy is deployed, based on the intended deployment location. This number will remain the same throughout the life of the buoy. In our example, the buoy identifier is 93503.

Groups YYMMJ (the day, month, and year) and GGggi_w are nearly identical to the bathy code identification groups. except for the indicator i_w used as the last digit of the group. This code figure is used to indicate the units of wind speed (1 = meters per second, 4 = knots). In our example, the date and time of the observation are provided by 23027 11454, for the 23d of February, 1997, at 11452. The indicator 4 shows the wind is measured in knots.

The buoy's position is given by the groups $Q_cL_aL_aL_aL_aL_a$ $L_OL_OL_OL_OL_OL_O$. Notice that these are each 6-digit groups instead of the standard 5-digit groups. As in the bathy code, Q_c is quadrant of the globe from WMO code table 3333 (refer to Appendix III). However, $L_aL_aL_aL_aL_a$ is the latitude to the nearest thousandth of a degree (3 decimal places). Likewise, $L_oL_oL_oL_oL_oL_o$ is the longitude to the nearest thousandth of a degree. A report may replace the last figure in each group with a slant if the position is only reported to the nearest hundredth of a degree. For example, 712238 095139 would report a position in

quadrant 7 (north of equator, west of prime meridian) as 12.238° North, 095.139° West, whereas 71224/09514/ is the same position reported only to the nearest hundredth of a degree.

The last part of the identification section is the optional group $6Q_1Q_tQ_A/$. This group is based on WMO Code Table 3334 and is used as a quality control indicator, with Q_1 and Q_A used for position and Q_t for time. This group must be encoded manually. See table 2-4.

METEOROLOGICAL DATA

Within the meteorological data section, winds, air temperature, dewpoint temperature, and relative humidity may be reported. In addition, pressure data, such as station pressure, sea level pressure, and 3 hour pressure tendency, may also be reported. Each group in section 1 is only reported if the buoy actually measures the information. All groups are identical to the ship Synoptic code (WMO 13-X SHIP), except for the use of the group indicator 0 for the wind data group and the relative humidity group (29UUU).

The meteorological section is identified by the group $111Q_dQ_x$. The code figure Q_d is the quality control indicator, and Q_x indicates the position of any one group in this section that is not good, if applicable. Otherwise, Q_x is encoded as a 9. In our example, the groups 00308 10255 29075 30132 40133 52003 report winds from 030° true at 08 knots, air temperature 25.5°C, relative humidity of 75%, station pressure of 1013.2 hPa, and sea-level pressure at 1013.3 hPa. The last group is the pressure tendency and amount of change (hPa) during the past 3 hours. Only three codes are used for tendency (2 = pressure increasing, 4 = pressure steady, 7 = pressure decreasing). In our example, the pressure is indicated as rising and up 0.3 hPa.

SURFACE MARITIME DATA

As with the meteorological data, each section 2 surface maritime data group is only included if the information is measured by the buoy. The indicator $222Q_dQ_x$ will always precede any surface maritime data, but is itself omitted if no groups from section 2 are reported. The group $0s_nT_wT_wT_w$ is used to report the sea-surface temperature. The code figure s_n is the sign of the temperature (0 = positive, 1 = negative). For example, the group 00262 reports sea-surface temperature at 26.2°C.

Some buoys contain a sensor that measures wave action. If the sensor measures wave period to the nearest second and wave height to the nearest half-meter, code group $1P_{wa}P_{wa}H_{wa}H_{wa}$ is used. In our example, 10302 reports a wave period of 3 seconds, and a wave height as 2 half-meters (3 feet). Other buoys contain more accurate instruments that measure wave period to the nearest tenth of a second and wave height to the nearest tenth meter. These buoys report wave period to the nearest tenth of a second in the group $20P_{wa}P_{wa}P_{wa}$, and wave height to the nearest tenth meter in the group $21H_{wa}H_{wa}H_{wa}$.

OCEANOGRAPHIC DATA

Section 3 is used to report readings obtained from sensors on a drifting buoy's tail. Sensors are normally fixed to the tail at set intervals. Most drifting buoys only measure temperature, but more sophisticated buoys may include salinity measuring devices and water current measurement devices at various levels.

The data groups in the first portion of section 3 following the $333Q_{d1}Q_{d2}$ $8887k_2$ indicator groups are used to report seawater temperature and salinity readings. The Q_{d1} and Q_{d2} are used to indicate the quality of the temperature/salinity profile and the quality of the current (set and drift) profile, respectively. The indicator k_2 is the method used for the salinity measurement as per WMO Code 2263 (0 = no measurement, 1 = electronic sensor with better than 0.02% accuracy, 2 = electronic sensor with less than 0.02% accuracy, and 3 = sample analysis). As of the late 1990s few buoys carry salinity sensors.

Table 2-4.—WMO Code Table 3334

Q_d = Quality control indicator
Q_{d1} = Quality control indicator for temperature/ salinity.
Q_{d2} = Quality control indicator for current (set/drift) profile.
Q_1Q_A = Quality control indicator for position.
Q_t = Quality control indicator for time.
Code Figure
0 = Data not checked
1 = Data good
2 = Data inconsistent
3 = Data doubtful
4 = Data wrong
5 = Data value has been changed

The three groups, $2z_nz_nz_nz_n$, $3T_nT_nT_nT_n$, and $4S_nS_nS_nS_n$, are repeated for each level of measured data. The $z_nz_nz_nz_n$ reports each depth in whole meters. For example, 20001 reports a depth of 1 meter below surface, and 20150 reports a depth of 150 meters. Temperatures are reported by $T_nT_nT_nT_n$ to the nearest hundredth degree Celsius, with 5,000 added to the temperature to indicate values below zero degree Celsius. In our example, 20010 31820 reports a temperature of 18.20°C at 10 meters. A report 35120 would indicate a temperature of-1.20°C. The salinity group $4s_ns_ns_ns_n$ is only included if salinity measurements have been made. This group reports salinity to the nearest hundredth of a part-per-thousand. A report of 43472, for example, is 34.72%.

In the second portion of section 3, under-sea current set and drift is reported. This report, if included, will be preceded by an indicator group $66k_69k_3$. Indicator k_6 refers to WMO Code Table 2267, the method used to correct the current measurement for the buoy's movement. Indicator k_3 is the indicator for the duration and time of the data sampling for the current measurement from WMO Code Table 2264. Neither are significant for decoding purposes. For each level where the current is reported, the depth is reported by using a $2z_nz_nz_nz_n$ group, and then the direction and speed of the current are reported in the group $d_nd_nc_nc_nc_n$. The d_nd_n reports the set of the current (direction towards) in tens ofdegrees True, while $c_nc_nc_n$ reports the drift of the current in centimeters per second (hundredth of a meter-per-second). For rough approximations, doubling the meters-per-second value yields a value in knots. For example, 20150 18135 reports the current at 150 meters moving toward the south (set = 180° True) at 2.7 knots (drift = 135 centimeters or 1.35 meters-per-second).

QUALITY CONTROL DATA

Section 4 of the report, beginning with the indicator 444, reports quality control information. Actual movement of the buoy may be reported in this section and may be interpreted as a surface current speed and direction. Many values after the 444 indicator may be ignored for normal data applications. However, personnel assigned data monitor duties at activities where the reports are received, must encode these values to signify if the buoy is functioning properly. Normally, if a buoy sensor is operating within acceptable limits, the information in this section will not appear in the transmitted report. Thus, the absence of this section, with the exception of the $8V_iV_iV_iV_i$ and the 9idZdZdZd groups, indicates satisfactory operation Of the buoy.

In order of appearance in the code, Q_P is the quality of the pressure report; Q_2 is the quality of the buoys "house-keeping"; Q_{TW} is the quality of the sea-surface temperature report, and 44 is the quality of the air-temperature report; Q_N is the quality of the satellite transmission; and Q_L and Q_A are the quality of the reported location. When the quality of the reported buoy position in section 0 is doubtful, a second latitude/longitude group may be repeated in this section.

The actual movement of the buoy may also be reported in this section as an aid in determining buoy location. The movement of the buoy may be used as an approximate surface water current, especially if a drogue anchor is affixed to the buoy, The buoy movement group, $7V_BV_BdBdB$, begins with the date/time of the last known position using a YYMMJ GGgg/ group. The speed of movement, V_BV_B, is given in centimeters per second (multiplied by .10). The direction of movement, d_Bd_B, is given in tens of degrees. In our example, 71227 would indicate that the buoy has moved at 2.4 knots (120 centimeters or 1.20 meters-per-second) toward the west (270° True).

The $8V_iV_iV_iV_i$ group contains an engineering code. Ignore this group.

The $9i_dZ_dZ_dZ_d$ group contains buoy cable (drogue) data. The code figure i_d indicates the type of drogue used. The last 3 digits in the group, $Z_dZ_dZ_d$, is the length of the drogue in meters.

Surface meteorological observations from drifting buoys are normally automatically processed and plotted on computer-produced surface charts. The bathymetric reports are not routinely plotted. The positions of the buoys should be monitored and the bathymetric data entered into TESS or MOSS when buoys are near your operating area. These reports will expand your USW area prediction capabilities.

REVIEW QUESTIONS

Q31. What information is contained in section 2 of the drifting buoy code?

Q32. What is the data identifier for a drifting buoy report?

Q33. When a drifting buoy is reporting good temperature/salinity data, but doubtful ocean current data, what is encoded at the beginning of section 3 in the drifting buoy report?

Q34. What would the groups 20050 32234 43547 in section 3 of a drifting buoy message indicate?

Q35. How would an ocean current data group of 20020 15097 be interpreted in a drifting buoy message?

SUMMARY

In this chapter, we have reviewed the three basic properties that affect sound velocity in seawater. We discussed the various uses of bathythermograph data, and also discussed the two types of bathythermograph recording systems used by fleet units. The procedures used to evaluate raw BT data and to encode and record the data were also covered. Finally, we explained how to decode BUOY reported bathymetric data.

ANSWERS TO REVIEW QUESTIONS

A1. Salinity.

A2. Temperature.

A3. Pressure.

A4. US W support.

A5. Analyze fronts, eddies, and other oceanographic thermal features, provide input into oceanographic forecasts, build climatological data bases, and assist in research and development of oceanographic and acoustic models.

A6. At the synoptic hours (00Z, 06Z, 12Z, 18Z) and when entering areas of differing ocean thermal structure such as in the vicinity affronts, eddies, major river outflow areas, etc.

A7. 1,500 feet.

A8. The RO-326B or RO-326C/SSQ-56 recorder, the MX-8577/SSQ-61 launcher, and the OC-14/SSQ-56 XBT probe.

A9. Expendable bathythermograph.

A10. The ready-for-launch mode calibration temperature and the alignment of the stylus on the surface depth line.

A I I. A built-in tape recorder.

A12. Connection to the Navy Tactical Data System (NTDS).

A13. Sound velocity trace.

A14. Direct measurement of sound velocity.

A15. Leak from probe wire to salt water.

A16. Sharp variations in ocean thermal structure caused by fronts, eddies, etc.

A17. Positive gradient.

A18. Surface. mixed layer, tops and bases of isothermal layers, significant inflection points, and the deepest part of the trace.

A19. 20.

A20. Reference/identification information.

A21. All the following data is reported in English units.

A22. The outside air temperature.

A23. 01104.

A24. 99904 20034.

A25. 9990131426.

A26. That the bottom depth is 364 meters, at 10.2°C.

A27. The direction the ocean current is moving towards.

A28. NAVMETOCCOMINST 3140.1, United States Navy Meteorological and Oceanographic Support System Manual.

A29. Naval Oceanographic Office, Stennis Space Center, Mississippi.

A30. Six months.

A31. Surface marine data.

A32. ZZYY.

A33. 33313.

A34. At 50 meters, the seawater temperature is 22.34°C, and the salinity is 35.47 parts-per-thousand.

A35. At 20 meters, the set of the current is 150° at 09.7 centimeters per second.